

WHAT IS CLAIMED IS:

1. A multi-beam optical scanning apparatus comprising:

5 a light source unit having at least three light emitting portions disposed with being spaced from each other in a main-scanning direction;

a first optical system for changing conditions of at least three divergent light beams emitted from the light source unit;

10 a stop for restricting widths of the at least three light beams transmitted through the first optical system at least in the main-scanning direction;

15 a deflecting unit for reflecting the at least three light beams transmitted through the stop;

a second optical system for forming images of the at least three light beams reflected by the deflecting unit on a surface to be scanned; and

20 a detecting unit for detecting a writing start position synchronous signal for controlling timing of a scanning start position on the surface to be scanned, the writing start position synchronous signal detecting unit including a detecting device for detecting the writing start position synchronous
25 signal, and a slit member disposed in an optical path between the writing start position synchronous signal detecting device and the deflecting unit, and the

writing start position synchronous signal detecting unit being adapted to control the timing of the scanning start position on the surface to be scanned by using a light beam reflected by the deflecting
 5 unit and transmitted through the slit member;

wherein a condition given by

$$\left| P \sin \alpha \tan \beta + \frac{S_1 L_1}{f_1 f_2} (\delta M_{(\beta)} - \delta M_{(BD)}) \right| \leq \frac{25.4}{3N_M}$$

is satisfied, where S_1 is the spacing in the main-scanning direction between light emitting portions at
 10 opposite ends in the at least three light emitting portions, f_1 is the focal length of the first optical system, L_1 is the distance between the stop and a deflecting facet of the deflecting unit, f_2 is the focal length of the second optical system in the
 15 main-scanning direction, α is an average of angles formed between principal rays of the at least three light beams incident on the surface to be scanned and a normal to the surface to be scanned in a sub-scanning section, β is an average of angles formed
 20 between the principal rays of the at least three light beams incident at any scanning location on the surface to be scanned and the normal to the surface to be scanned in a main-scanning section, $\delta M_{(\beta)}$ is the main-scanning focus displacement amount at the

scanning location of the average β , $\delta M_{(BD)}$ is the
main-scanning focus displacement amount at a scanning
location whereat the at least three light beams pass
through the slit member, N_M is the number of pixels
5 per inch in the main-scanning direction which is
determined from a resolution in the main-scanning
direction on the surface to be scanned, and P is the
spacing in the sub-scanning direction between image
spots of light beams emitted from light emitting
10 portions at opposite ends in the at least three light
emitting portions on the surface to be scanned.

2. A multi-beam optical scanning apparatus
comprising:
- 15 a light source unit having at least three light
emitting portions disposed with being spaced from
each other in a main-scanning direction;
- a first optical system for changing conditions
of at least three divergent light beams emitted from
20 the light source unit;
- a stop for restricting widths of the at least
three light beams transmitted through the first
optical system at least in the main-scanning
direction;
- 25 a deflecting unit for reflecting the at least
three light beams transmitted through the stop;
- a second optical system for forming images of

the at least three light beams reflected by the deflecting unit on a surface to be scanned; and

a detecting unit for detecting a writing start position synchronous signal for controlling timing of
 5 a scanning start position on the surface to be scanned, the writing start position synchronous signal detecting unit including a third optical system disposed independently from the second optical system, a detecting device for detecting the writing
 10 start position synchronous signal, and a slit member disposed in an optical path between the writing start position synchronous signal detecting device and the third optical system unit, and the writing start position synchronous signal detecting unit being
 15 adapted to control the timing of the scanning start position on the surface to be scanned by using a light beam reflected by the deflecting unit;

wherein a condition given by

$$\left| P \sin \alpha \tan \beta + \frac{S_1 L_1}{f_1 f_2} \delta M_{(\beta)} - \frac{S_1 L_1}{f_1 f_3} \delta M_{(BD)} \right| \leq \frac{25.4}{3N_M}$$

20 is satisfied, where S_1 is the spacing in the main-scanning direction between light emitting portions at opposite ends in the at least three light emitting portions, f_1 is the focal length of the first optical system, L_1 is the distance between the stop and a

deflecting facet of the deflecting unit, f_2 is the focal length of the second optical system in the main-scanning direction, f_3 is the focal length of the third optical system in the main-scanning
5 direction, α is an average of angles formed between principal rays of the at least three light beams incident on the surface to be scanned and a normal to the surface to be scanned in a sub-scanning section, β is an average of angles formed between the
10 principal rays of the at least three light beams incident at any scanning location on the surface to be scanned and the normal to the surface to be scanned in a main-scanning section, $\delta M_{(\beta)}$ is the main-scanning focus displacement amount at the scanning
15 location of the average β , $\delta M_{(BD)}$ is the main-scanning focus displacement amount at a scanning location whereat the at least three light beams pass through the slit member, N_M is the number of pixels per inch in the main-scanning direction which is determined
20 from a resolution in the main-scanning direction on the surface to be scanned, and P is the spacing in the sub-scanning direction between image spots of light beams emitted from light emitting portions at opposite ends in the at least three light emitting
25 portions on the surface to be scanned

3. A multi-beam optical scanning apparatus

according to claim 1, wherein the writing start
position synchronous signal detecting unit is adapted
to control the timing of the scanning start position
on the surface to be scanned by using all of the at
5 least three light beams reflected by the deflecting
unit.

4. A multi-beam optical scanning apparatus
according to claim 2, wherein the writing start
10 position synchronous signal detecting unit is adapted
to control the timing of the scanning start position
on the surface to be scanned by using all of the at
least three light beams reflected by the deflecting
unit.

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5. A multi-beam optical scanning apparatus
according to claim 1, wherein the slit member is
adapted to be movable in a direction in which the at
least three light beams incident on the slit member
20 travel.

6. A multi-beam optical scanning apparatus
according to claim 2, wherein the slit member is
adapted to be movable in a direction in which the at
25 least three light beams incident on the slit member
travel.

7. A multi-beam optical scanning apparatus
according to claim 1, wherein the slit member is
adapted to be rotatable in a section approximately
perpendicular to the direction in which the at least
5 three light beams incident on the slit member travel.

8. A multi-beam optical scanning apparatus
according to claim 2, wherein the slit member is
adapted to be rotatable in a section approximately
10 perpendicular to the direction in which the at least
three light beams incident on the slit member travel.

9. A multi-beam optical scanning apparatus
according to claim 1, wherein a light beam reflected
15 by the deflecting unit and incident on the writing
start position synchronous signal detecting device is
adapted to pass through the second optical system.

10. An image forming apparatus comprising:
20 a multi-beam optical scanning apparatus recited
in any one of claims 1 to 9;

a photosensitive member disposed on the surface
to be scanned;

a developing device for developing as a toner
25 image an electrostatic latent image formed on the
photosensitive member by the light beams scanned by
the multi-beam optical scanning apparatus;

a transferring device for transferring the developed toner image onto a transferring material; and

a fixing device for fixing the transferred
5 toner image to the transferring material.

11. An image forming apparatus comprising:

a multi-beam optical scanning apparatus recited in any one of claims 1 to 9; and

10 a printer controller for converting code data input from an external equipment into an image signal, and inputting the image signal into the multi-beam optical scanning apparatus.

15 12. A color image forming apparatus comprising: multi-beam optical scanning apparatuses recited in any one of claims 1 to 9; and

a plurality of image bearing members each of which is disposed on the surface to be scanned of
20 each of the multi-beam optical scanning apparatuses, and on which different color images are formed, respectively.

13. A color image forming apparatus according
25 to claim 12, further comprising a printer controller for converting color signals input from an external equipment into image data of different colors, and

inputting the image data into the multi-beam optical scanning apparatuses, respectively.

14. A multi-beam optical scanning apparatus
5 comprising:

a light source unit having at least three light emitting portions disposed with being spaced from each other in a main-scanning direction;

a first optical system for changing conditions
10 of at least three divergent light beams emitted from the light source unit;

a stop for restricting widths of the at least three light beams transmitted through the first optical system at least in the main-scanning
15 direction;

a deflecting unit for reflecting the at least three light beams transmitted through the stop;

a second optical system for forming images of the at least three light beams reflected by the
20 deflecting unit on a surface to be scanned; and

a detecting unit for detecting a writing start position synchronous signal for controlling timing of a scanning start position on the surface to be scanned, the writing start position synchronous
25 signal detecting unit including a detecting device for detecting the writing start position synchronous signal;

wherein a condition given by

$$\left| P \sin \alpha \tan \beta + \frac{S_1 L_1}{f_1 f_2} (\delta M_{(\beta)} - \delta M_{(BD)}) \right| \leq \frac{25.4}{3N_M}$$

is satisfied, where S_1 is the spacing in the main-scanning direction between light emitting portions at
5 opposite ends in the at least three light emitting portions, f_1 is the focal length of the first optical system, L_1 is the distance between the stop and a deflecting facet of the deflecting unit, f_2 is the focal length of the second optical system in the
10 main-scanning direction, α is an average of angles formed between principal rays of the at least three light beams incident on the surface to be scanned and a normal to the surface to be scanned in a sub-scanning section, β is an average of angles formed
15 between the principal rays of the at least three light beams incident at any scanning location on the surface to be scanned and the normal to the surface to be scanned in a main-scanning section, $\delta M_{(\beta)}$ is the main-scanning focus displacement amount at the
20 scanning location of the average β , $\delta M_{(BD)}$ is the main-scanning focus displacement amount at a light receiving surface whereat the writing start position synchronous signal detecting device receives the at least three light beams, N_M is the number of pixels

per inch in the main-scanning direction which is determined from a resolution in the main-scanning direction on the surface to be scanned, and P is the spacing in the sub-scanning direction between image
5 spots of light beams emitted from light emitting portions at opposite ends in the at least three light emitting portions on the surface to be scanned.

15 15. A multi-beam optical scanning apparatus comprising:

a light source unit having at least three light emitting portions disposed with being spaced from each other in a main-scanning direction;

15 a first optical system for changing conditions of at least three divergent light beams emitted from the light source unit;

20 a stop for restricting widths of the at least three light beams transmitted through the first optical system at least in the main-scanning direction;

a deflecting unit for reflecting the at least three light beams transmitted through the stop;

25 a second optical system for forming images of the at least three light beams reflected by the deflecting unit on a surface to be scanned; and

a detecting unit for detecting a writing start position synchronous signal for controlling timing of

a scanning start position on the surface to be scanned, the writing start position synchronous signal detecting unit including a third optical system disposed independently from the second optical
5 system, and a detecting device for detecting the writing start position synchronous signal;

wherein a condition given by

$$\left| P \sin \alpha \tan \beta + \frac{S_1 L_1}{f_1 f_2} \delta M_{(\beta)} - \frac{S_1 L_1}{f_1 f_3} \delta M_{(BD)} \right| \leq \frac{25.4}{3N_M}$$

is satisfied, where S_1 is the spacing in the main-
10 scanning direction between light emitting portions at opposite ends in the at least three light emitting portions, f_1 is the focal length of the first optical system, L_1 is the distance between the stop and a deflecting facet of the deflecting unit, f_2 is the
15 focal length of the second optical system in the main-scanning direction, f_3 is the focal length of the third optical system in the main-scanning direction, α is an average of angles formed between principal rays of the at least three light beams
20 incident on the surface to be scanned and a normal to the surface to be scanned in a sub-scanning section, β is an average of angles formed between the principal rays of the at least three light beams incident at any scanning location on the surface to

be scanned and the normal to the surface to be scanned in a main-scanning section, $\delta M_{(\beta)}$ is the main-scanning focus displacement amount at the scanning location of the average β , $\delta M_{(BD)}$ is the main-scanning focus displacement amount at a light receiving surface whereat the writing start position synchronous signal detecting device receives the at least three light beams, N_M is the number of pixels per inch in the main-scanning direction which is determined from a resolution in the main-scanning direction on the surface to be scanned, and P is the spacing in the sub-scanning direction between image spots of light beams emitted from light emitting portions at opposite ends in the at least three light emitting portions on the surface to be scanned.

16. A multi-beam optical scanning apparatus according to claim 14, wherein the writing start position synchronous signal detecting unit is adapted to control the timing of the scanning start position on the surface to be scanned by using all of the at least three light beams reflected by the deflecting unit.

17. A multi-beam optical scanning apparatus according to claim 15, wherein the writing start position synchronous signal detecting unit is adapted

to control the timing of the scanning start position on the surface to be scanned by using all of the at least three light beams reflected by the deflecting unit.

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18. A multi-beam optical scanning apparatus according to claim 14, wherein a light beam reflected by the deflecting unit and incident on the writing start position synchronous signal detecting device is adapted to pass through the second optical system.

19. An image forming apparatus comprising:
a multi-beam optical scanning apparatus recited in any one of claims 14 to 18;

15 a photosensitive member disposed on the surface to be scanned;

a developing device for developing as a toner image an electrostatic latent image formed on the photosensitive member by the light beams scanned by the multi-beam optical scanning apparatus;

20 a transferring device for transferring the developed toner image onto a transferring material; and

a fixing device for fixing the transferred toner image to the transferring material.

25 20. An image forming apparatus comprising:

a multi-beam optical scanning apparatus recited
in claim 19; and

a printer controller for converting code data
input from an external equipment into an image signal,
5 and inputting the image signal into the multi-beam
optical scanning apparatus.

21. A color image forming apparatus comprising:
multi-beam optical scanning apparatuses recited
10 in any one of claims 14 to 18; and

a plurality of image bearing members each of
which is disposed on the surface to be scanned of
each of the multi-beam optical scanning apparatuses,
and on which different color images are formed,
15 respectively.

22. A color image forming apparatus according
to claim 21, further comprising a printer controller
for converting color signals input from an external
20 equipment into image data of different colors, and
inputting the image data into the multi-beam optical
scanning apparatuses, respectively.